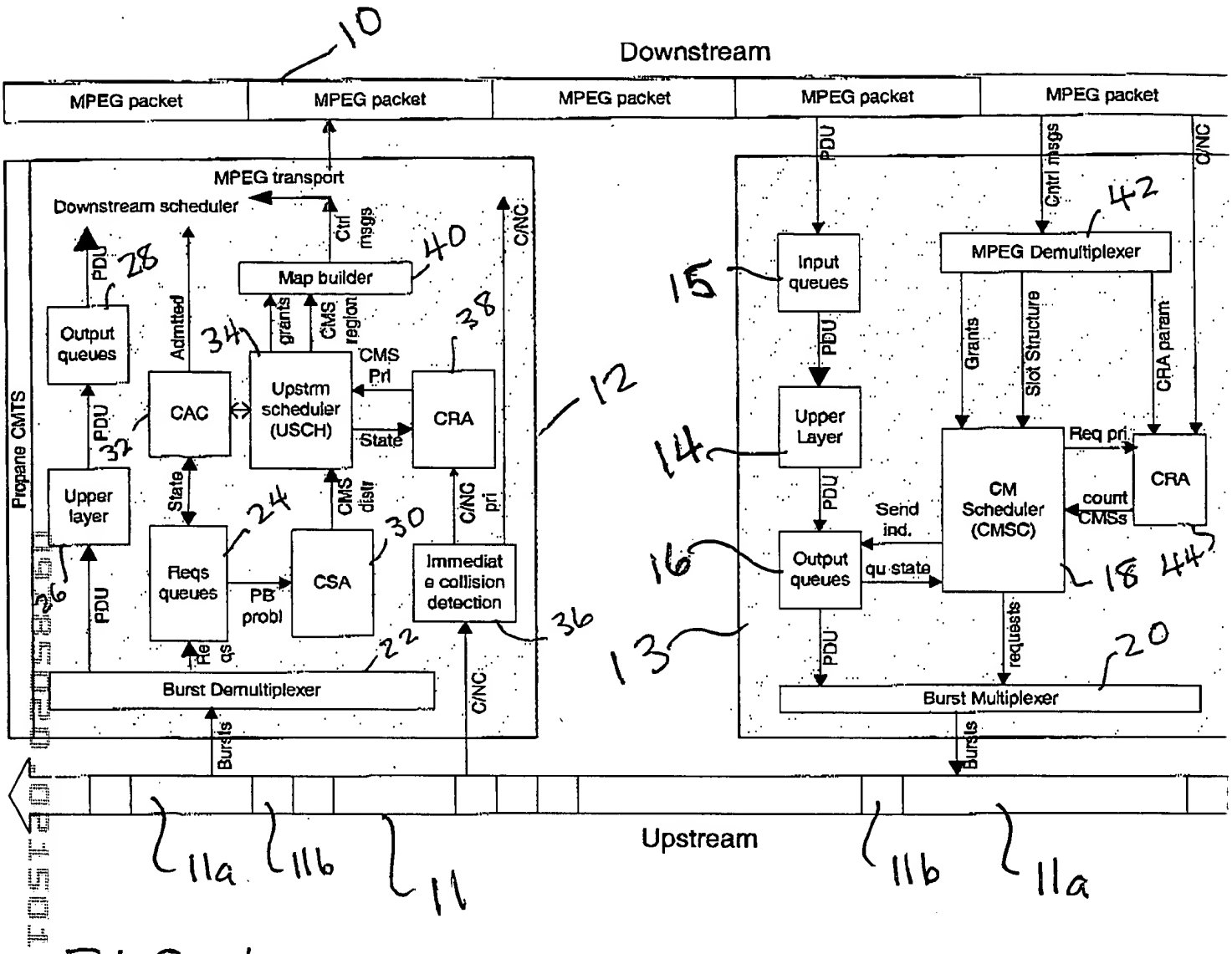
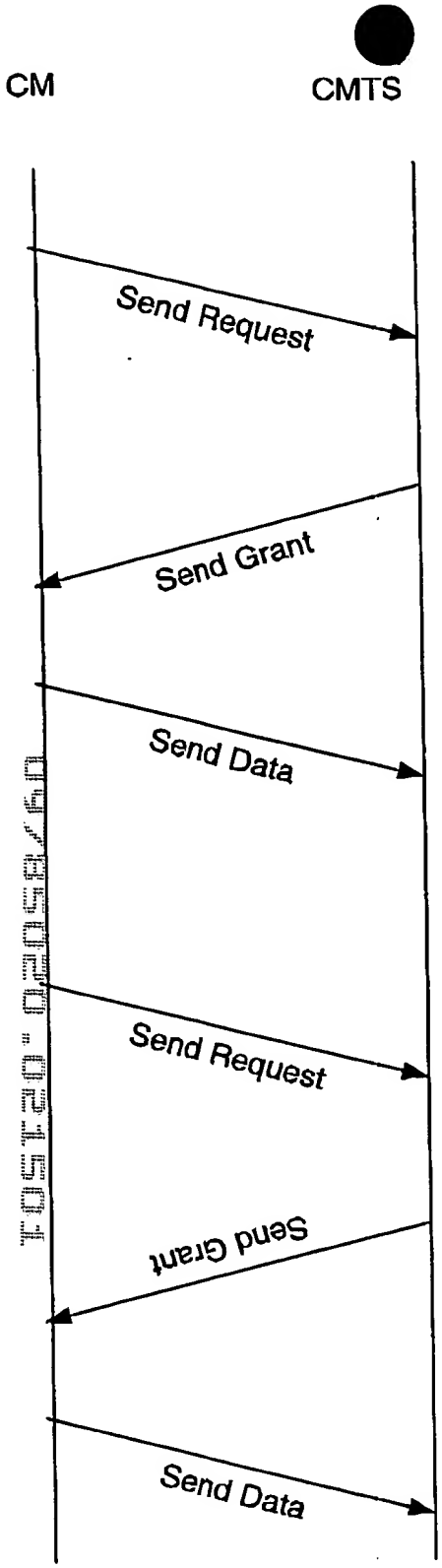
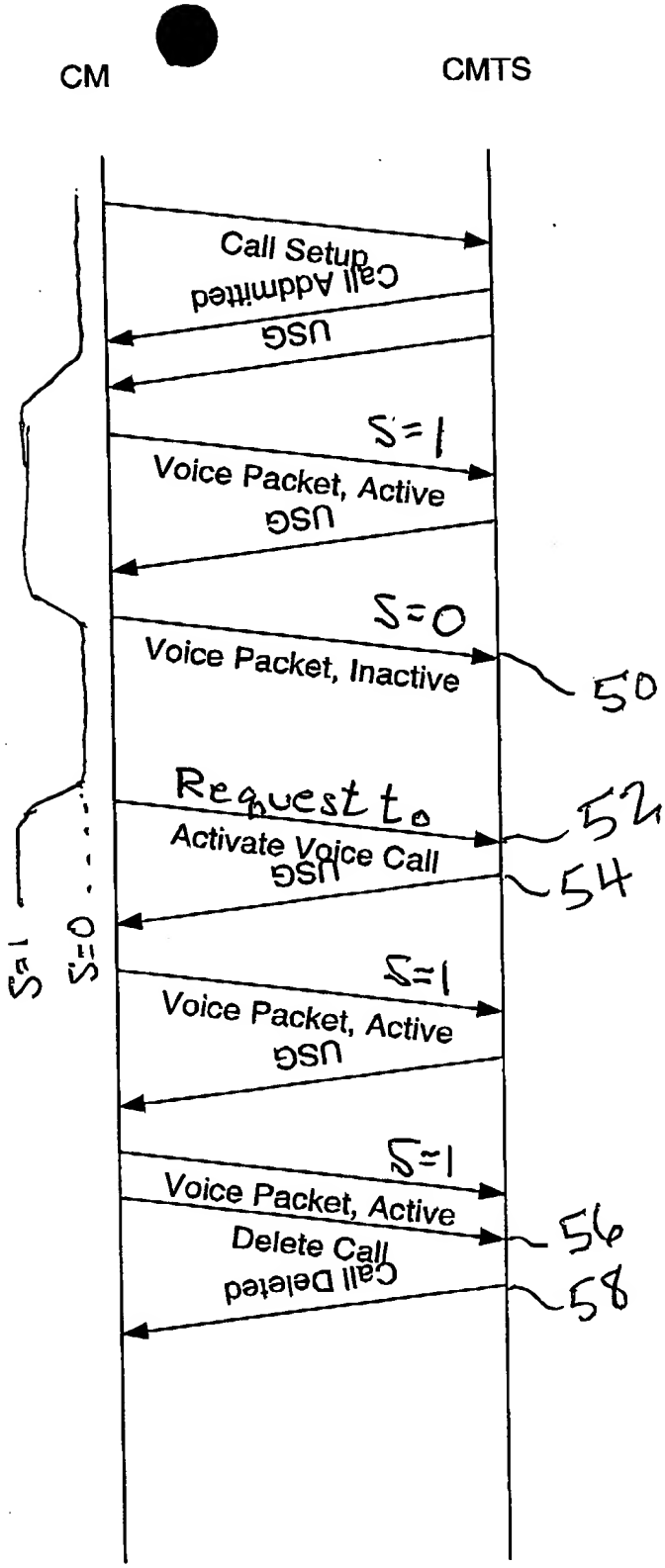

10
Downstream
MPEG packet
MPEG packet
MPEG packet
MPEG packet
MPEG packet
MPEG transport
Downstream scheduler
Ctrl msgs
C/NC
Map builder
40
PDU
28
Output queues
Admitted
34
grants
CMS region
38
CMS Pri
Upstrm scheduler (USCH)
CAC
CRA
State
12
PDU
32
Upper layer
State
24
CMS distr
C/NC pri
Reqs queues
PB probl
CSA
30
Immediat e collision detection
36
26
PDU
Reqs
22
Burst Demultiplexer
C/NC
Bursts
Propane CMTS
Input queues
15
PDU
Upper Layer
14
PDU
Output queues
16
13
PDU
Cntrl msgs
C/NC
42
MPEG Demultiplexer
Grants
Slot Structure
CRA param
Req pri
CRA
count CMSs
CM Scheduler (CMSC)
18
44
Send ind.
qu state
requests
20
Burst Multiplexer
Bursts
Upstream
11a
11b
11
11b
11a

FIG. 1



Data Service

FIG. 2A



Voice Service

FIG. 2B

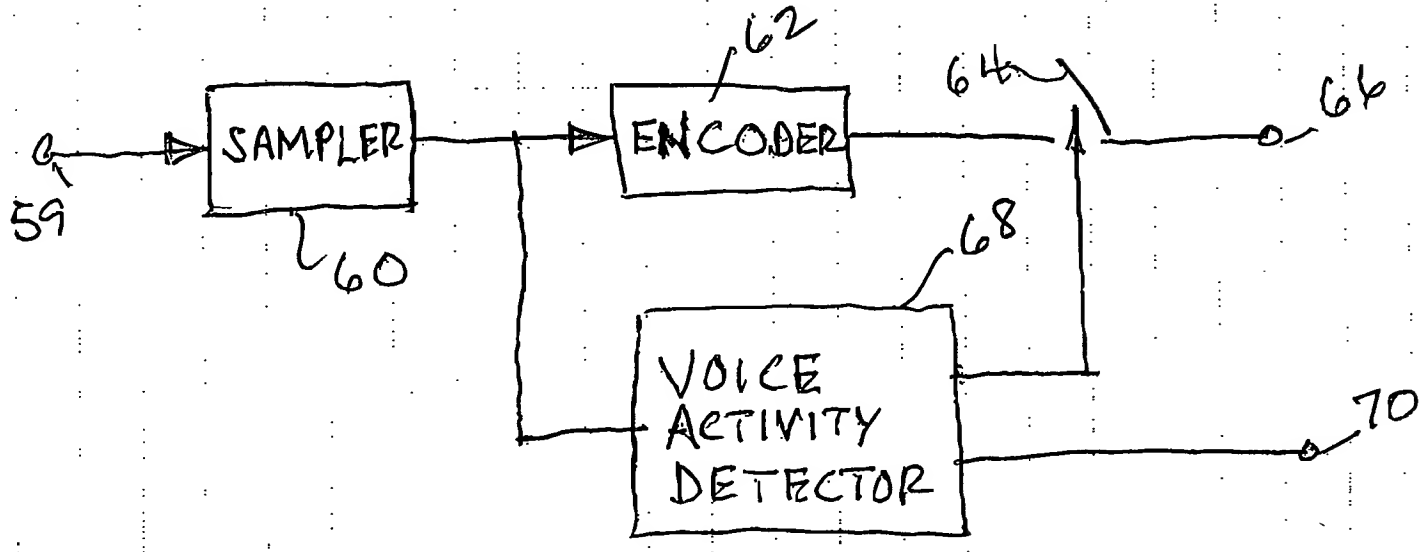


FIG. 3

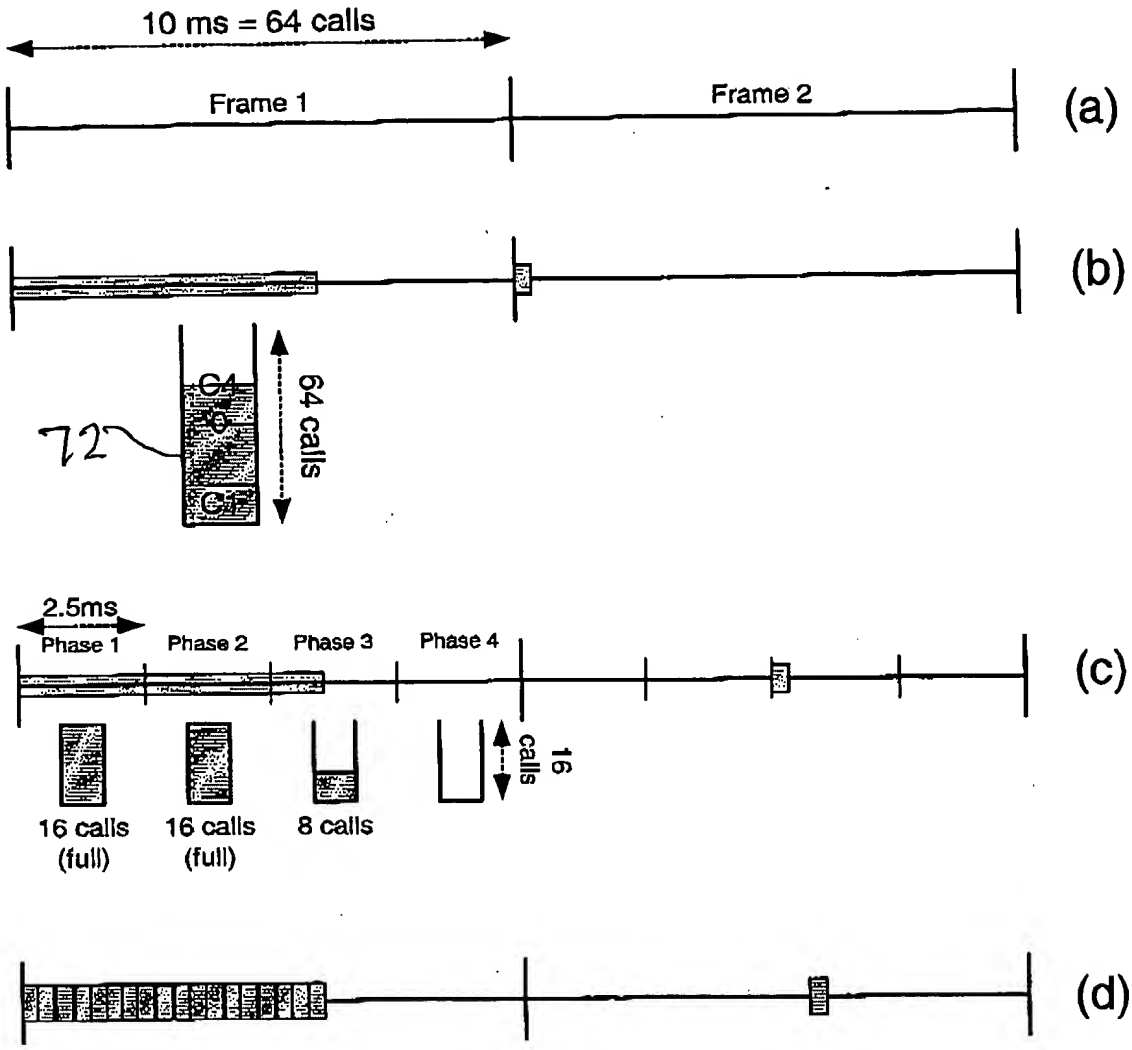

10 ms = 64 calls
Frame 1
Frame 2
(a)
(b)
72
C4
C1
64 calls
2.5ms
Phase 1
Phase 2
Phase 3
Phase 4
16 calls
(full)
16 calls
(full)
8 calls
16 calls
(c)
(d)

FIG. 4

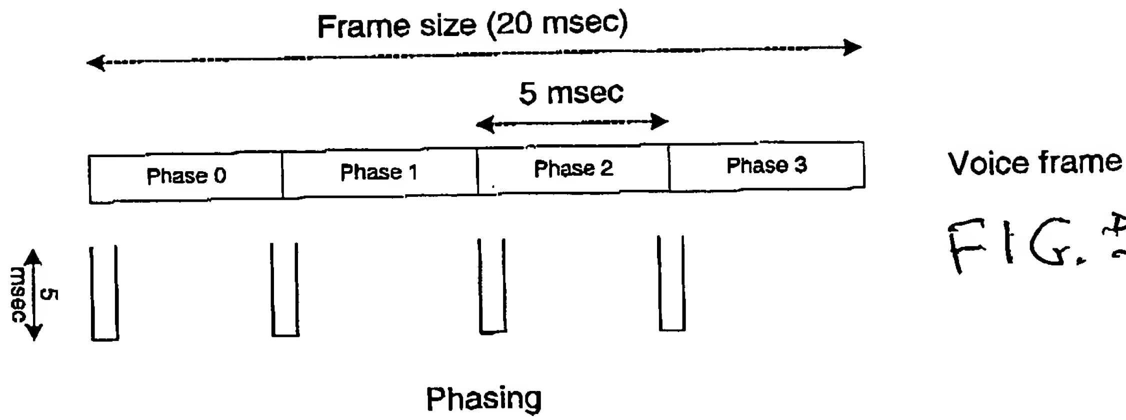


FIG. 5A

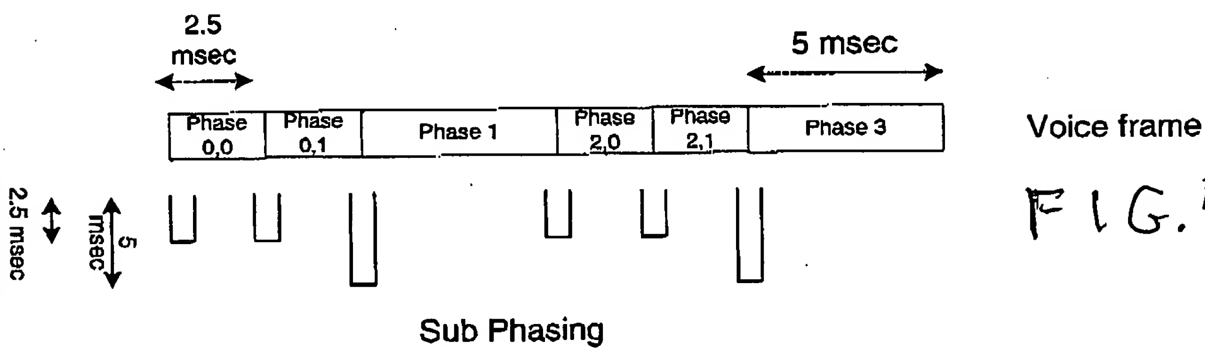


FIG. 5B

FIG. 5C

Call 1 : CM1, VID0: 5ms, 16 Kbps = 2 MS (1:0)
Call 2 : CM2, VID0: 10ms, 32 Kbps = 4 MS (2:0)
Call 3: CM3, VID0: 20ms, 32 Kbps = 7 MS (3:0)
Call 4: CM4, VID0: 20ms, 32 Kbps = 7 MS (4:0)
Call 5: CM1, VID1: 10ms, 16 Kbps = 3 MS (1:1)
Call 6: CM2, VID1: 10ms, 16 Kbps = 3 MS (2:1)

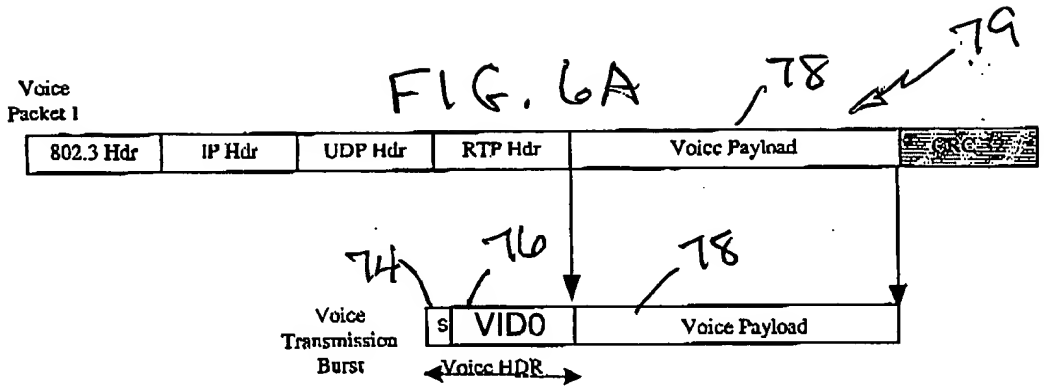


FIG. 6A

Mapping VoIP Packets into Voice PDUs

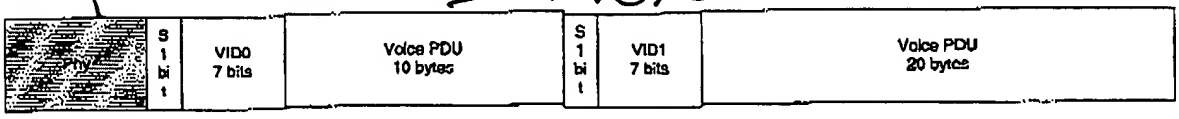


FIG. 6B

Concatenation of two voice channels of different rates

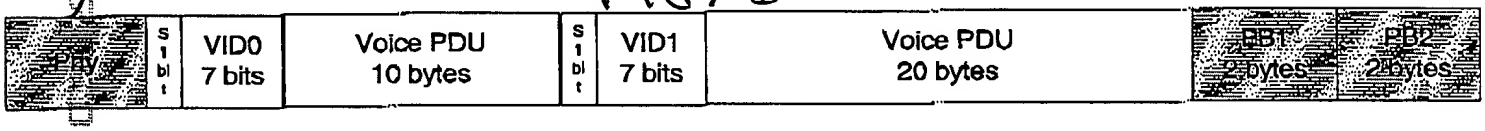


FIG. 6C

Concatenation of voice channels and piggybacking requests

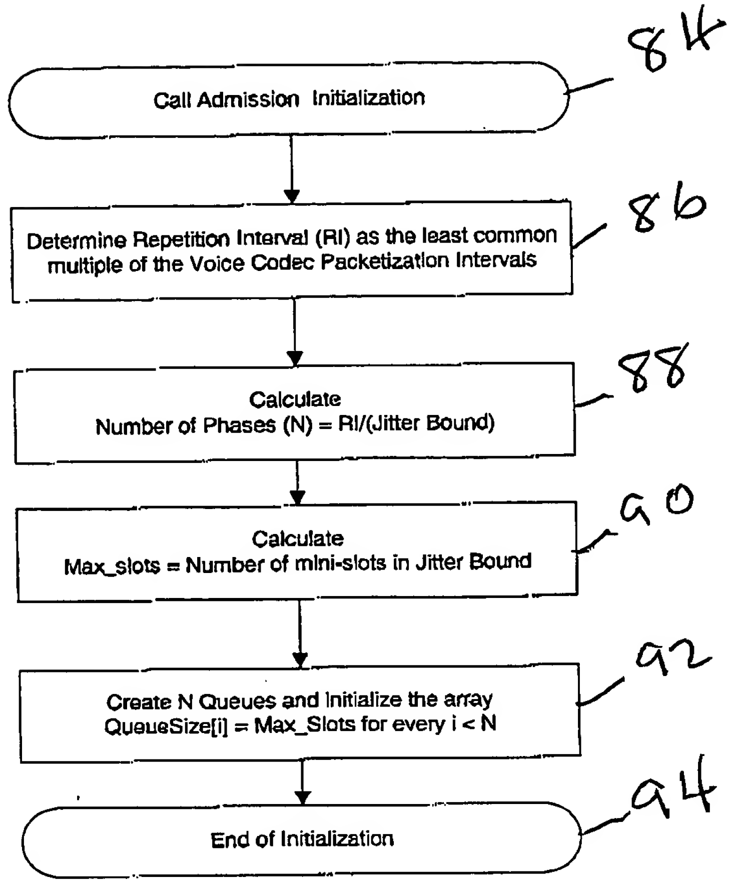


FIG. 7

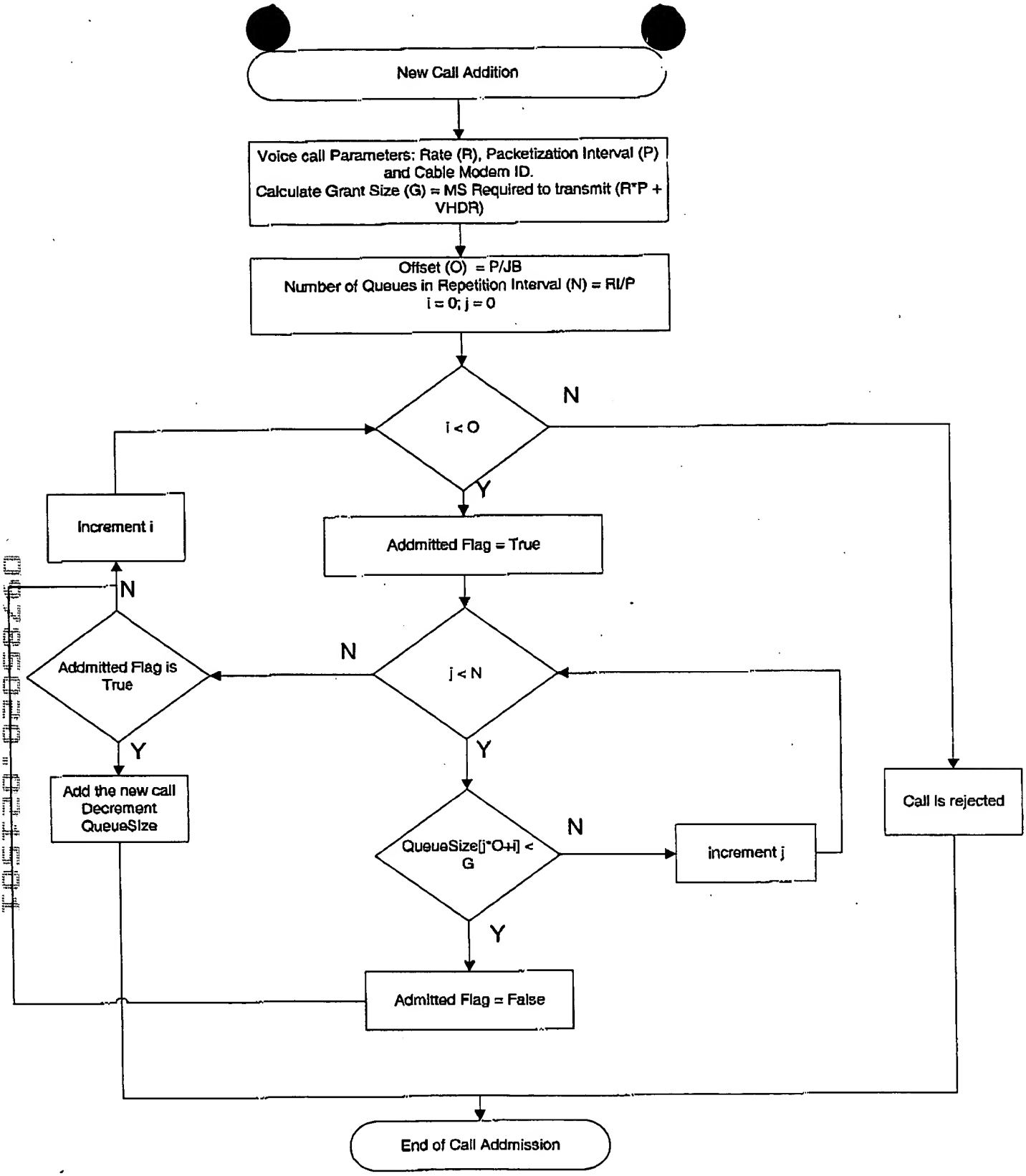
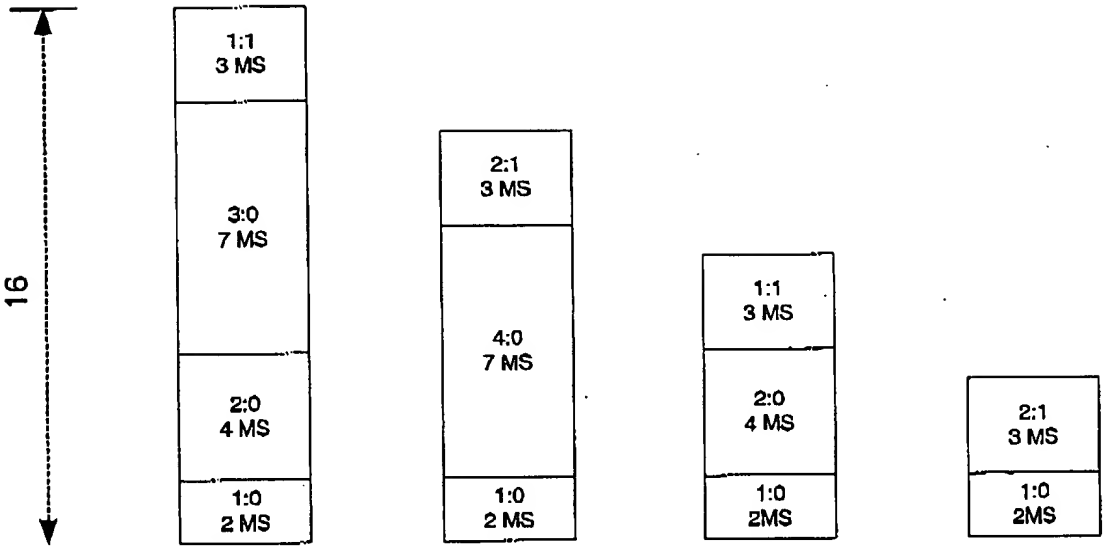
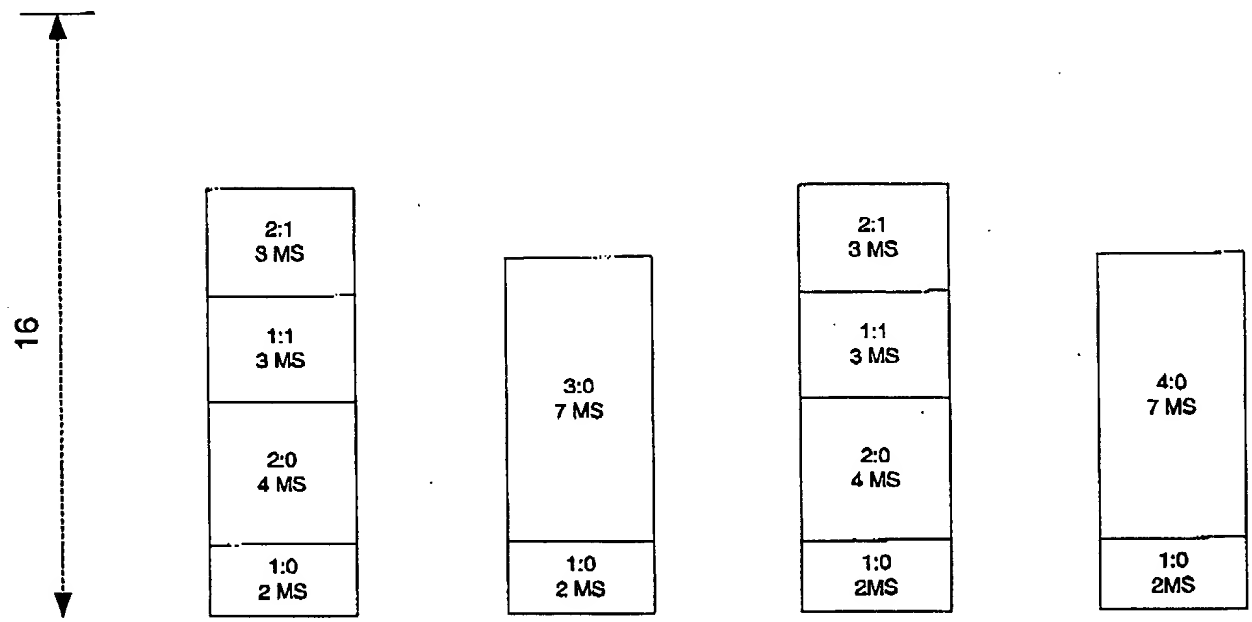

New Call Addition
Voice call Parameters: Rate (R), Packetization Interval (P) and Cable Modem ID.
Calculate Grant Size (G) = MS Required to transmit (R*P + VHDR)
Offset (O) = P/JB
Number of Queues in Repetition Interval (N) = RI/P
i = 0; j = 0
i < O
N
Y
Increment i
Addmitted Flag = True
N
Addmitted Flag is True
N
j < N
Y
Y
Add the new call
Decrement QueueSize
QueueSize[j*O+i] < G
N
increment j
Y
Call is rejected
Admitted Flag = False
End of Call Addmission

FIG. 8



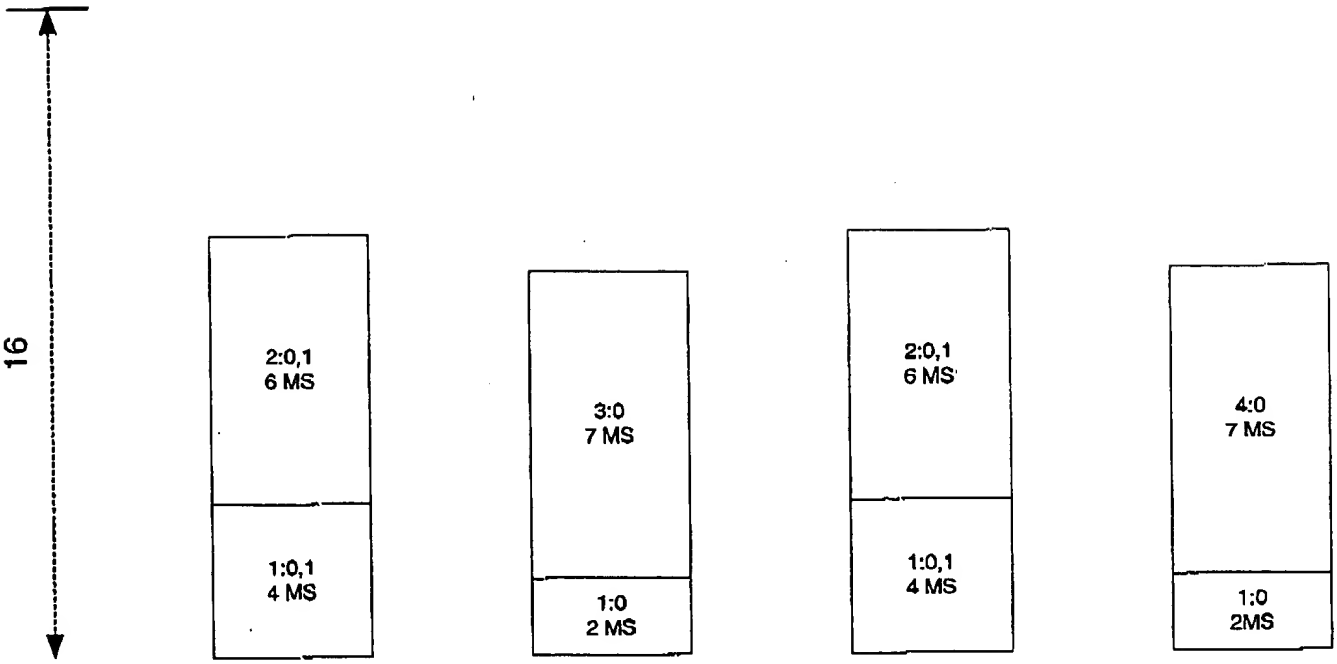
Call Admission: Unbalanced

FIG. 9



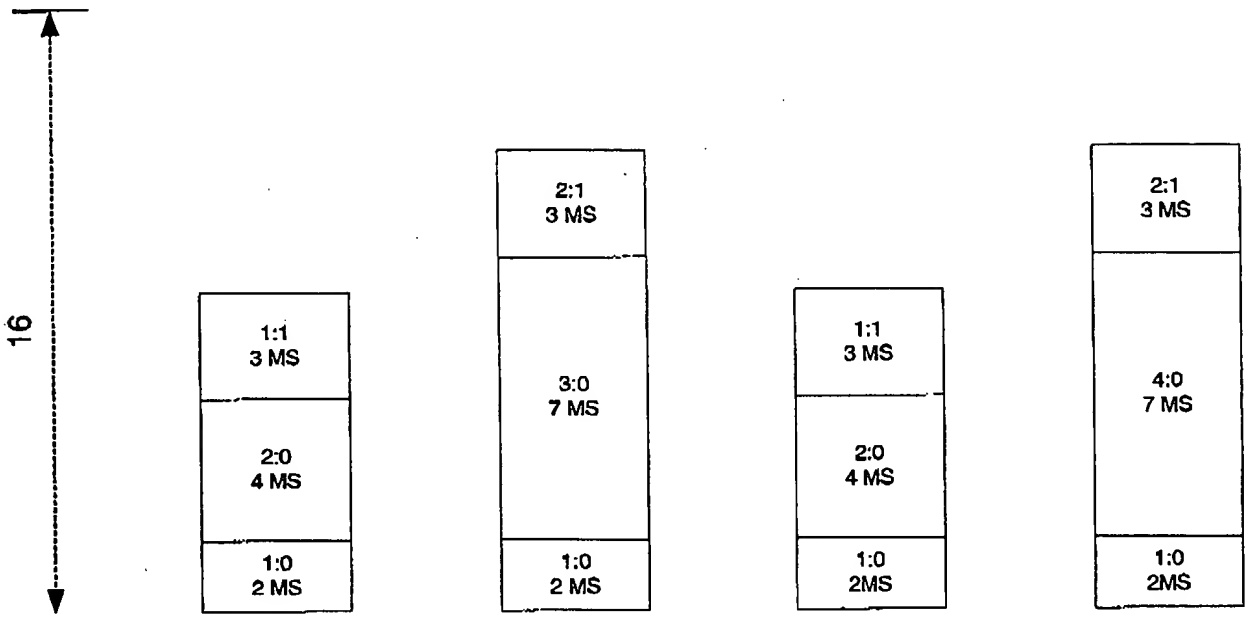
Call Admission: Balanced

FIG. 10



Call Admission: Balanced with Concatenation

FIG. 11



Call Admission: Balanced and Distributed CM Allocation

FIG. 12

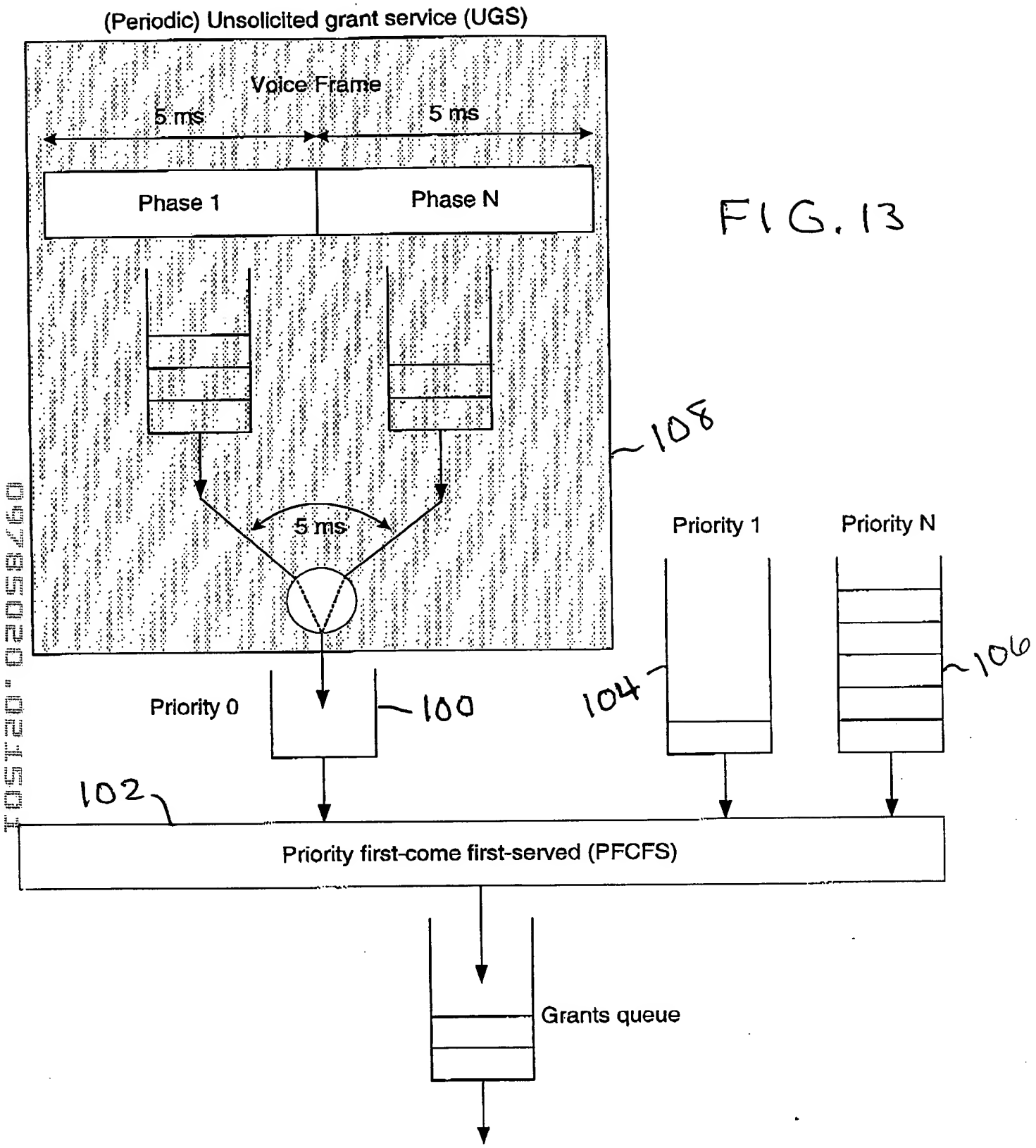

(Periodic) Unsolicited grant service (UGS)
Voice Frame
5 ms
5 ms
Phase 1
Phase N
5 ms
108
Priority 1
Priority N
Priority 0
100
104
106
102
Priority first-come first-served (PFCFS)
Grants queue

FIG. 13

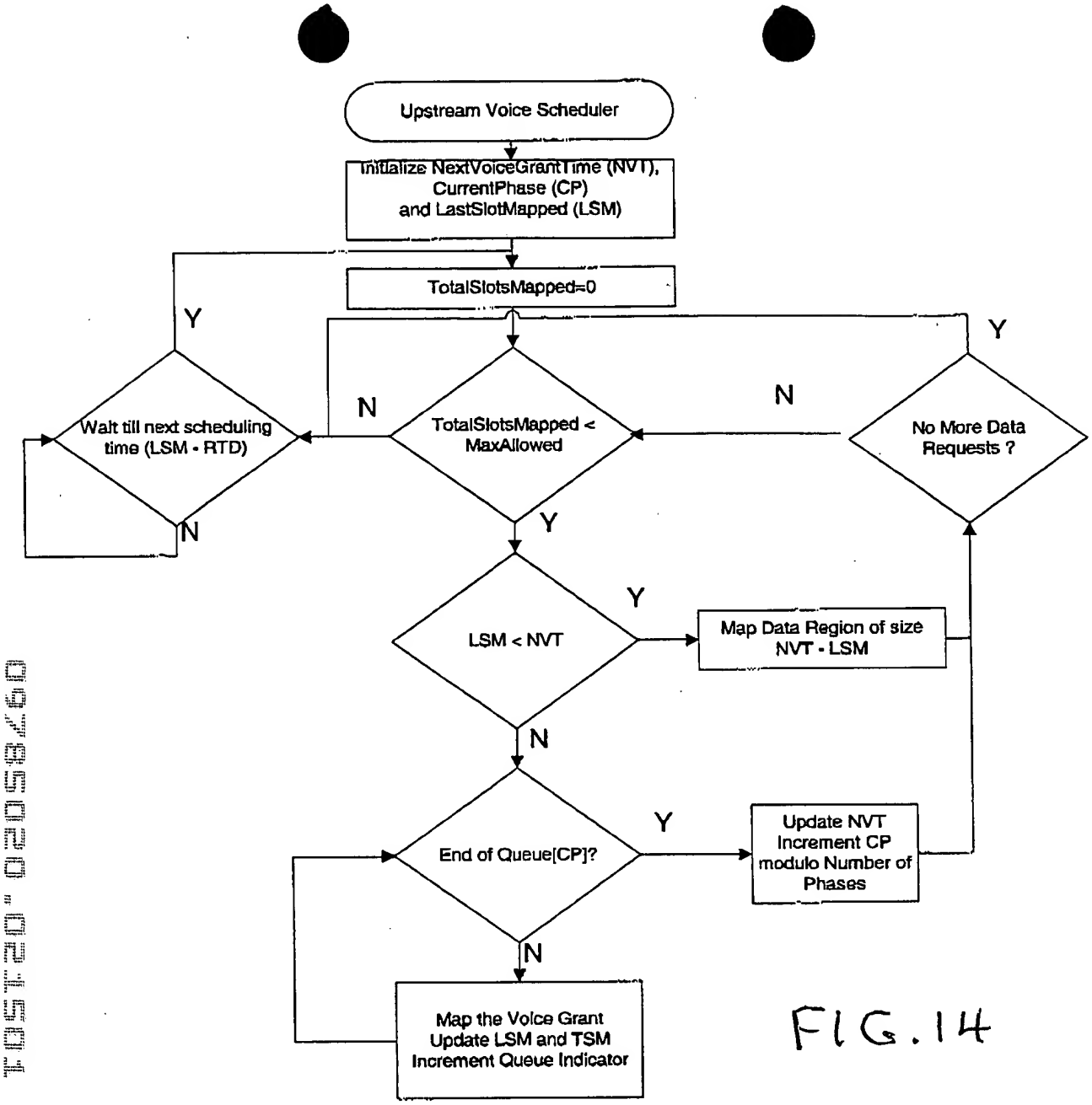
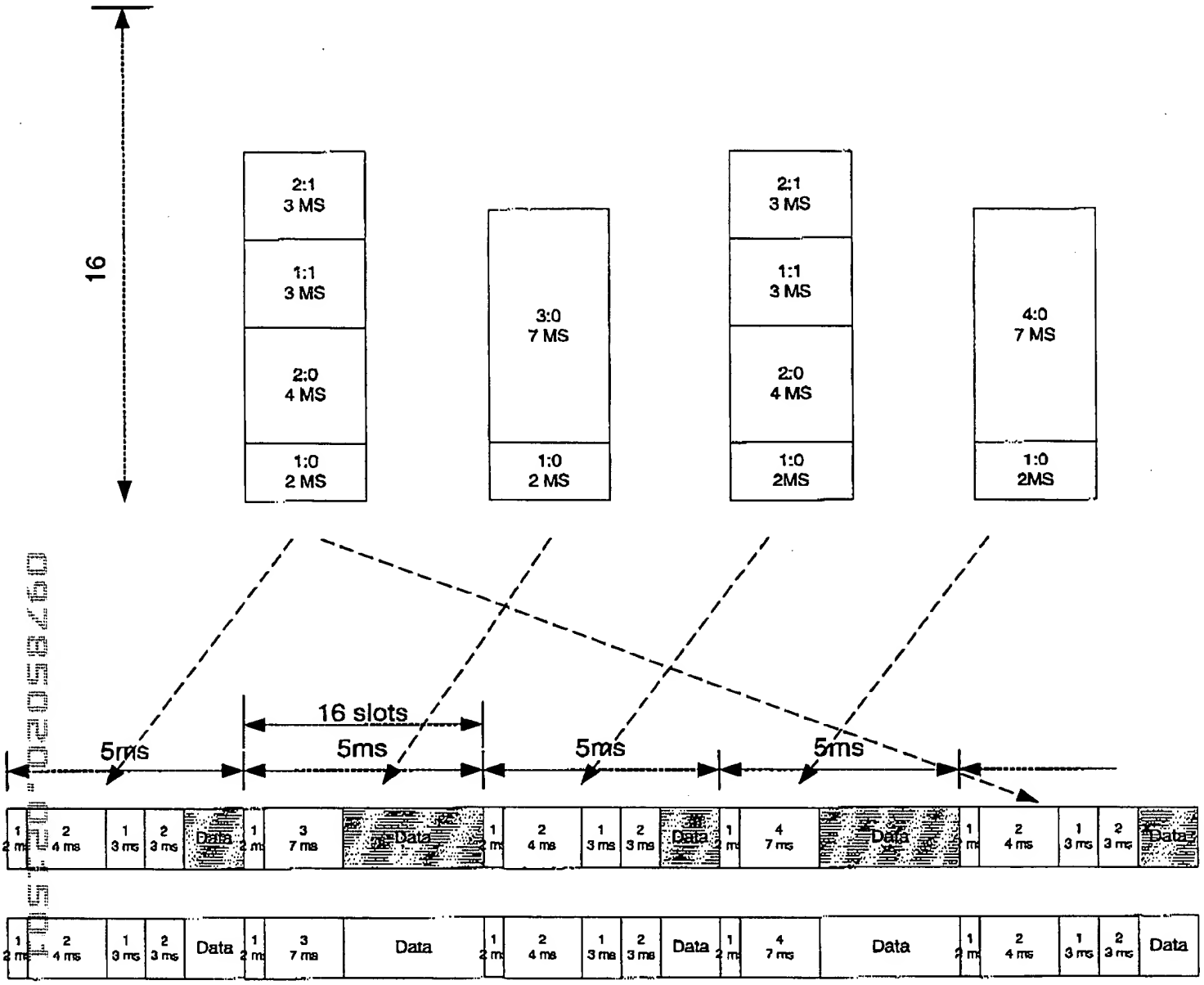
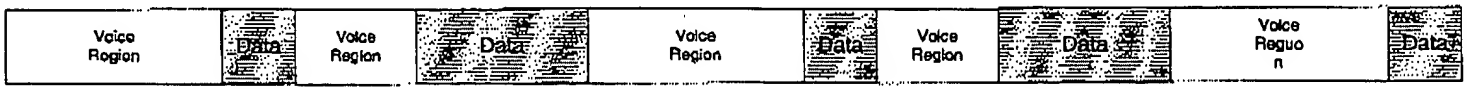

Upstream Voice Scheduler
Initialize NextVoiceGrantTime (NVT), CurrentPhase (CP) and LastSlotMapped (LSM)
TotalSlotsMapped=0
Wait till next scheduling time (LSM - RTD)
TotalSlotsMapped < MaxAllowed
No More Data Requests ?
LSM < NVT
Map Data Region of size NVT - LSM
End of Queue[CP]?
Update NVT Increment CP modulo Number of Phases
Map the Voice Grant Update LSM and TSM Increment Queue Indicator
Y
N

FIG. 14



Voice Region in the Upstream



Data Region in the Upstream

Voice Scheduling : Mapping Voice State into Upstream Grants

FIG. 15

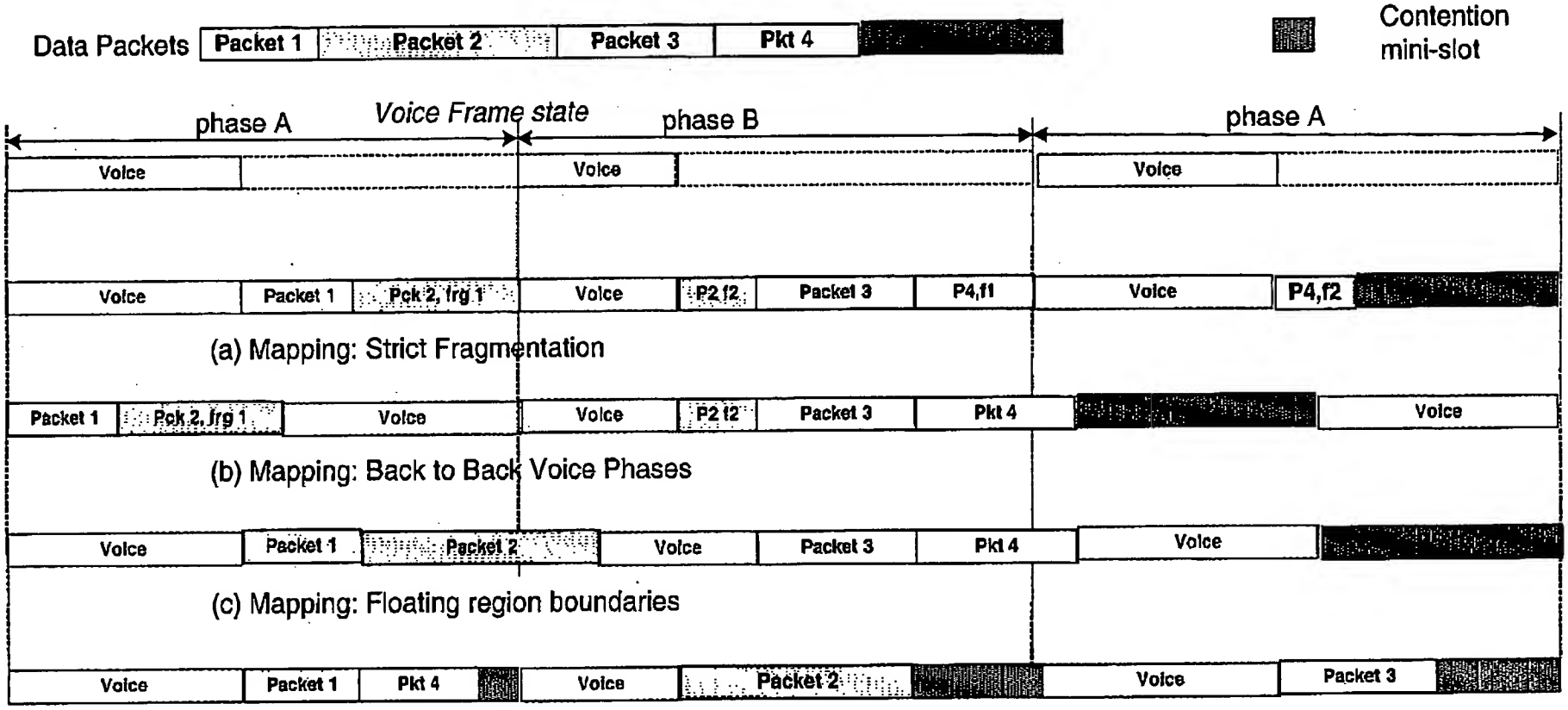


FIG. 16

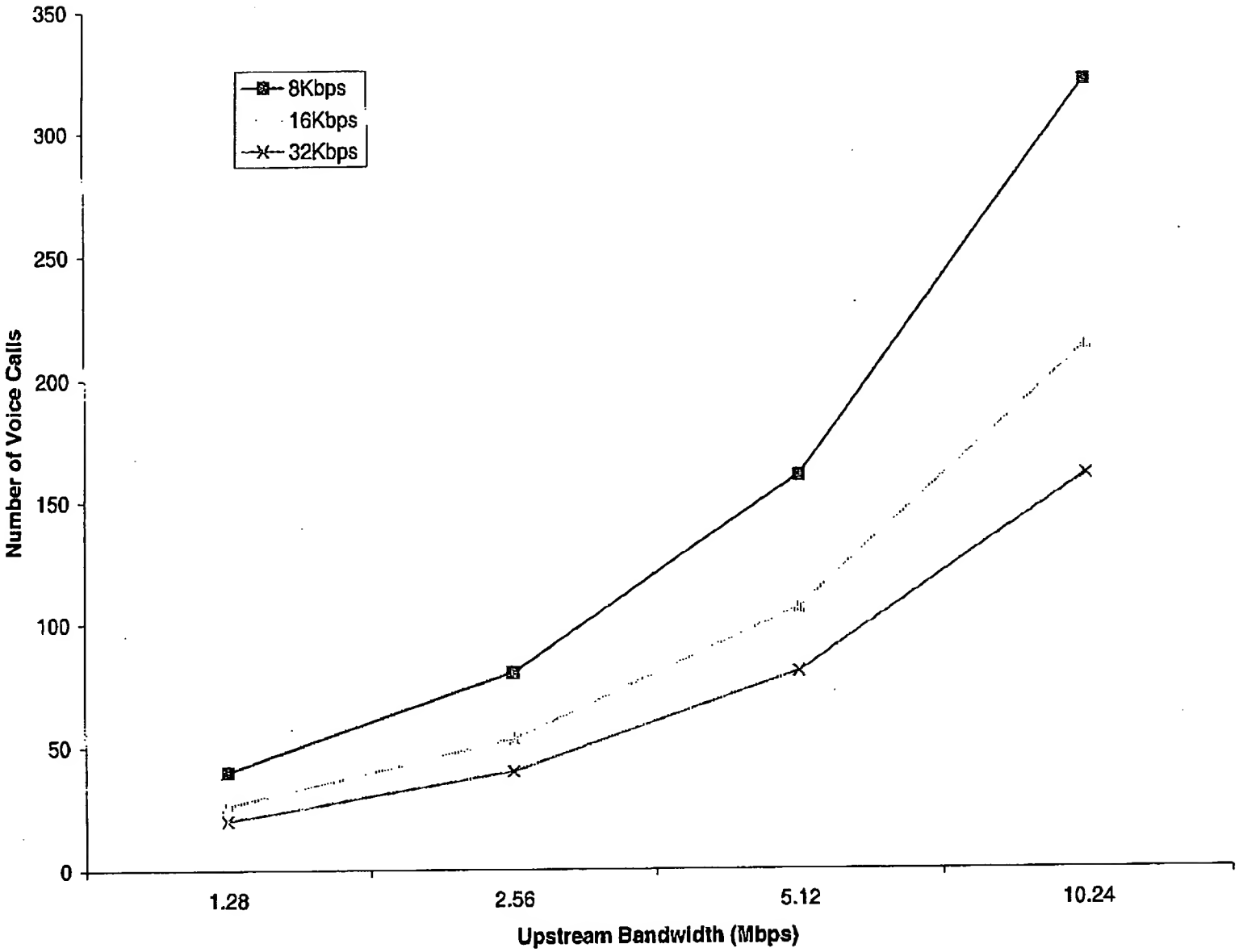


FIG. 17

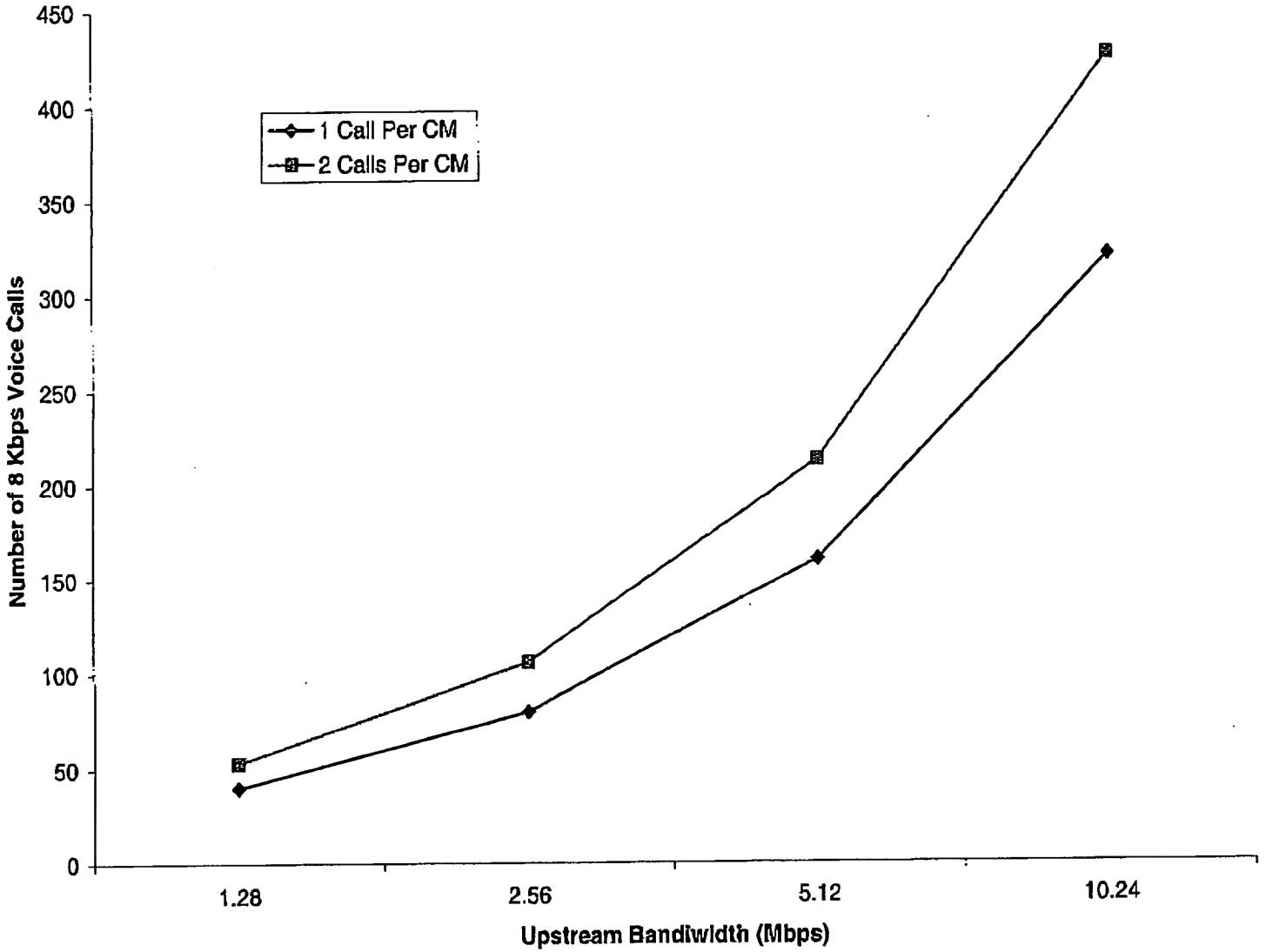

450
400
350
300
250
200
150
100
50
0
1 Call Per CM
2 Calls Per CM
Number of 8 Kbps Voice Calls
1.28
2.56
5.12
10.24
Upstream Bandiwidth (Mbps)

FIG. 18

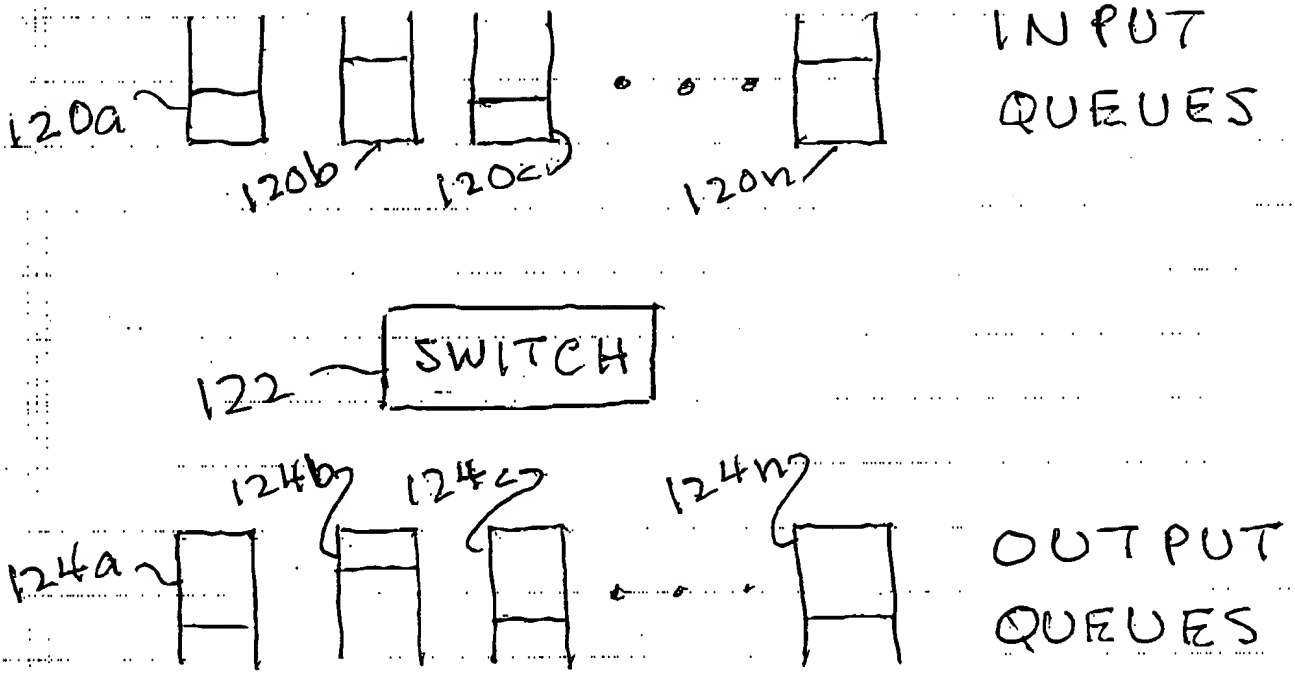

120a
120b
120c
120n
INPUT QUEUES
122
SWITCH
124a
124b
124c
124n
OUTPUT QUEUES

FIG. 19